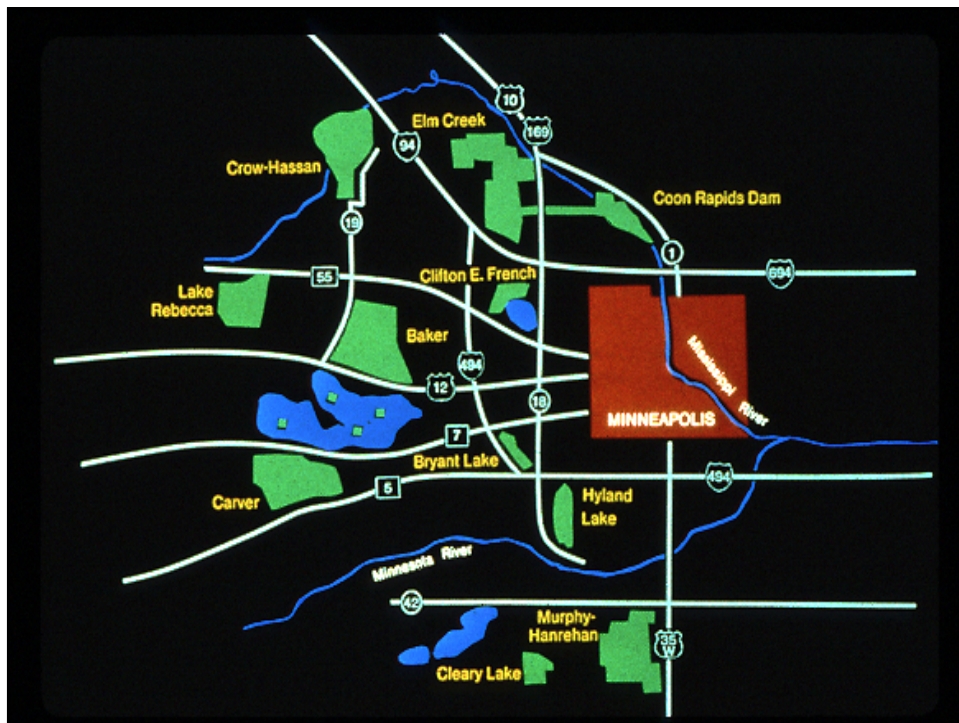


# Stormwater BMP Monitoring

Rain Garden Effectiveness  
Phosphorus Free Lawn Fertilizer Use



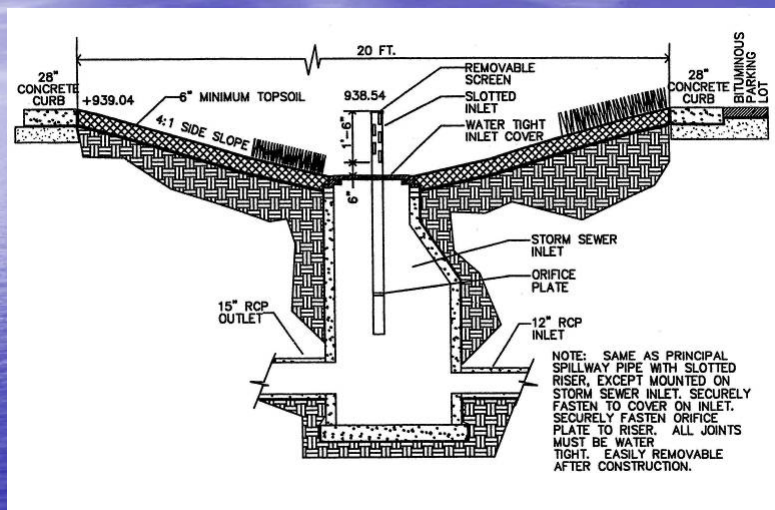
## Rain Garden – Drainage Area Characteristics

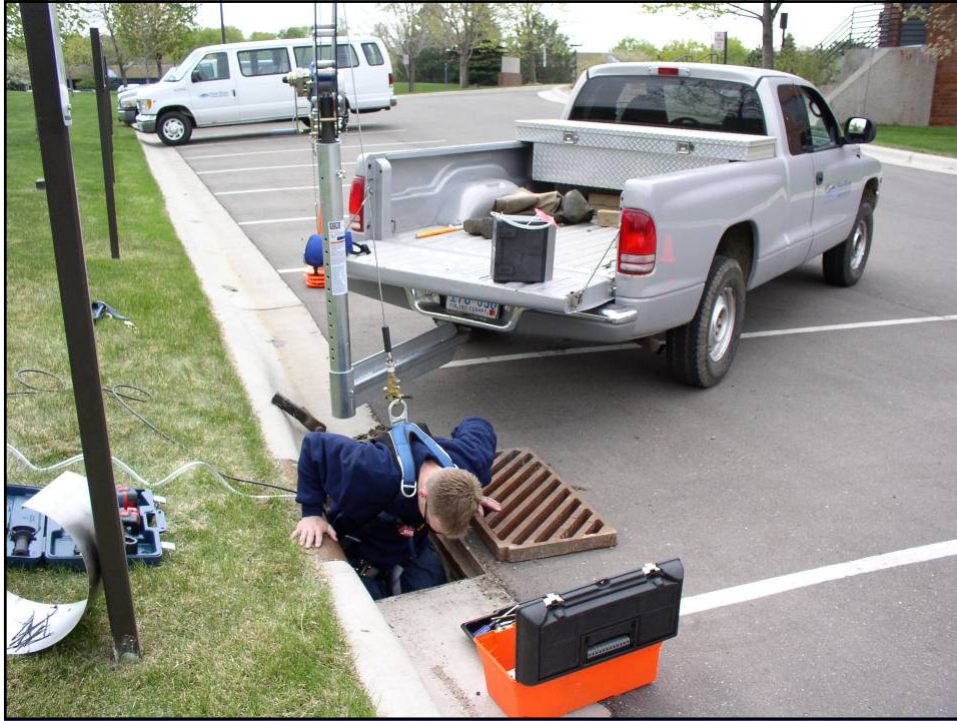
- 1.15 Acre Parking Lot
- 64% Impervious
- Pervious area – turf
- Commercial Land Use Zoning
- Runoff sheet flows into garden

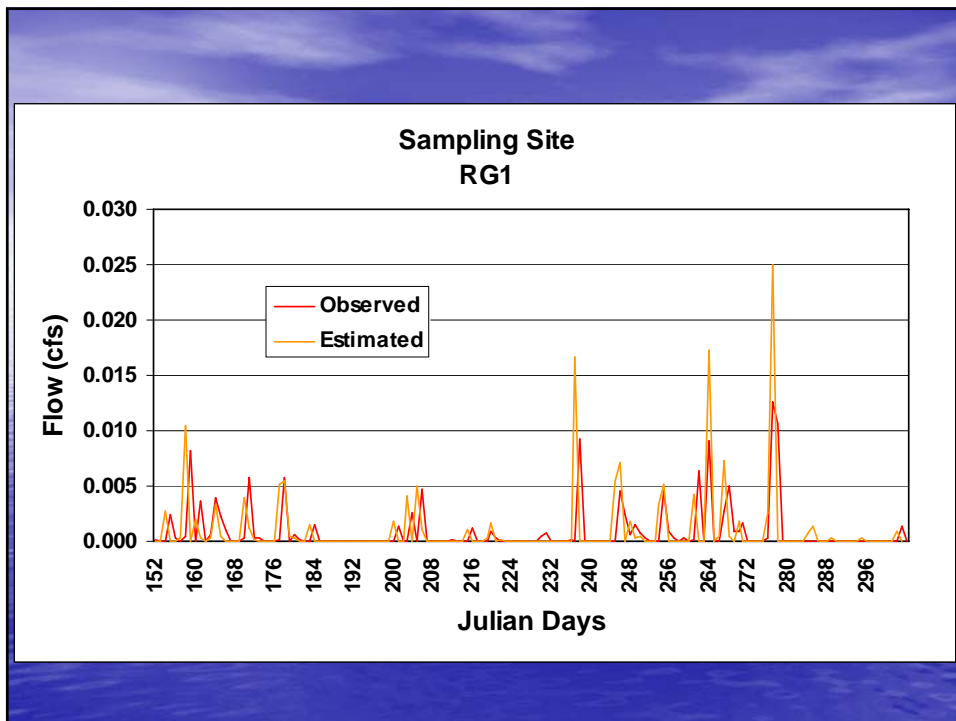
## Rain Garden Characteristics

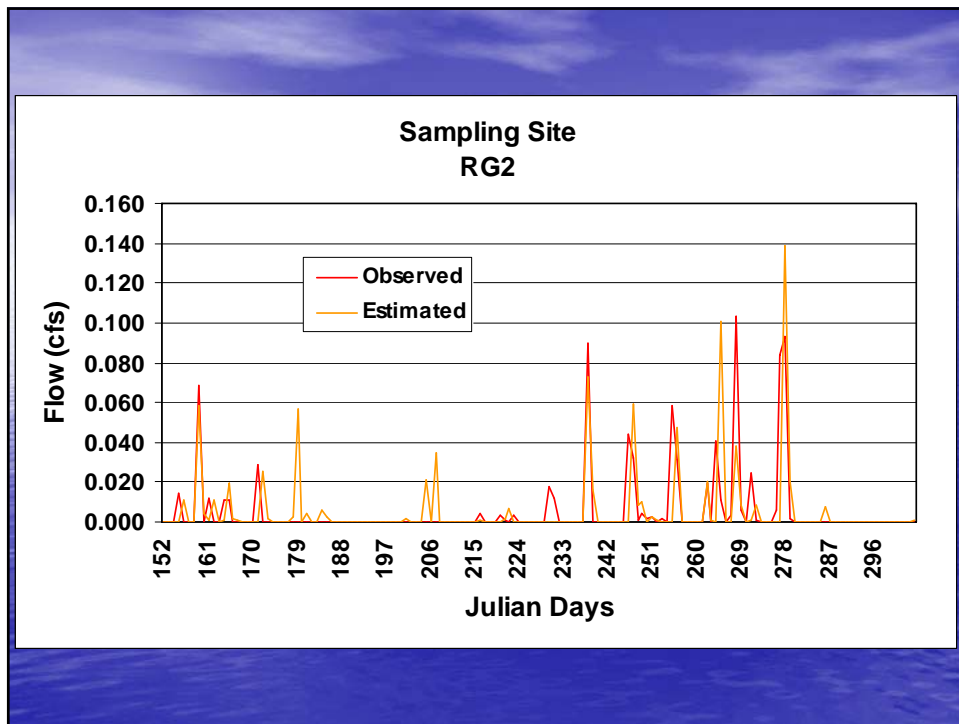
- 3,180 Square Foot Area
- 152 feet long
- 20 feet wide
- Sandy Loam Soils – 3"/hour design infiltration rate
- Constructed 2002
- Native Prairie Plants
- Discharges to Impaired Waterbody











## Rain Garden Effectiveness

Parameter	In	Out	% Removal
Flow (ac-ft)	2.09	1.60	23%
TP (lbs)	1.01	0.36	63%
TN (lbs)	6.38	2.64	57%
TSS (lbs)	316.8	40.4	87%

## BMP Monitoring Challenges

- Difficult to find systems with single inflow and outflow points
- Rainfall patterns are never “average”
- Automated monitoring equipment needs continual maintenance and calibration
- Rainfall events abide by Murphy's Law – worst possible time and worst magnitude

## Effect of a Phosphorus Fertilizer Ordinance on Runoff Water Quality



*Image courtesy of the Washington State Water Quality Consortium*

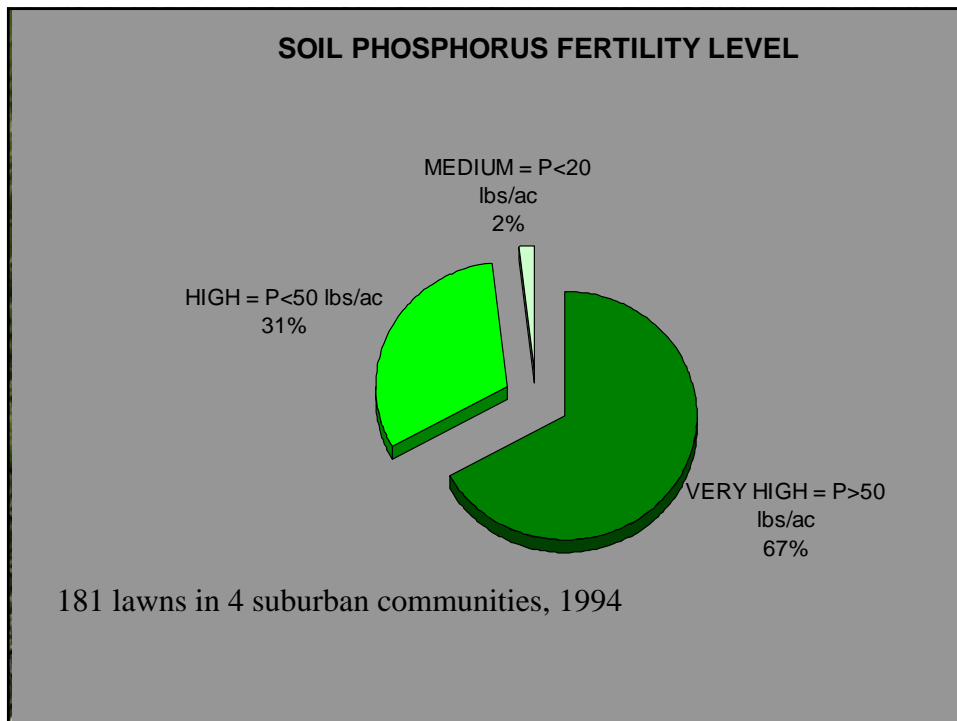
### **EMPACT: Lake Access 2**

*Three Rivers Park District (formerly Hennepin Parks)*

*University of Minnesota: Natural Resources Research Institute*

*Minnesota Sea Grant*

*Minnehaha Creek Watershed District*



LEWIS COUNTY HERB  
PLYMOUTH, PA 55441 Laboratory No. 519  
Date Received 05/2  
Date Reported 06/0

### Soil Test Results

Sample Designation	Soil Texture	Soil pH	Buffer Index	Organic Matter	P Phosphorus (ppm)	K Potassium (ppm)	Soluble Salts (mmhos)
PL 32	MEDIUM	7.4		MEDIUM	46	74	

PPM X 2 = LB/ACRE

### INTERPRETATION OF SOIL TESTS

Phosphorus (P) \*\*\*\*\* \*\*\*\*\* \*\*\*\*\* \*\*\*\*\*

Potassium (K) \*\*\*\*\* \*\*\*\*\* \*\*\*\*\* \*\*\*\*\*

pH \*\*\*\*\* \*\*\*\*\* \*\*\*\*\* \*\*\*\*\*

Soluble Salts \*\*\*\*\* \*\*\*\*\* \*\*\*\*\* \*\*\*\*\*

### RECOMMENDATIONS FOR HOME LAWN

LINE RECOMMENDATION: 0 LBS/1,000 SQ.FT. GRASS NOT WATERED CLIPPINGS M

TOTAL AMOUNT OF EACH NUTRIENT TO APPLY PER YEAR:

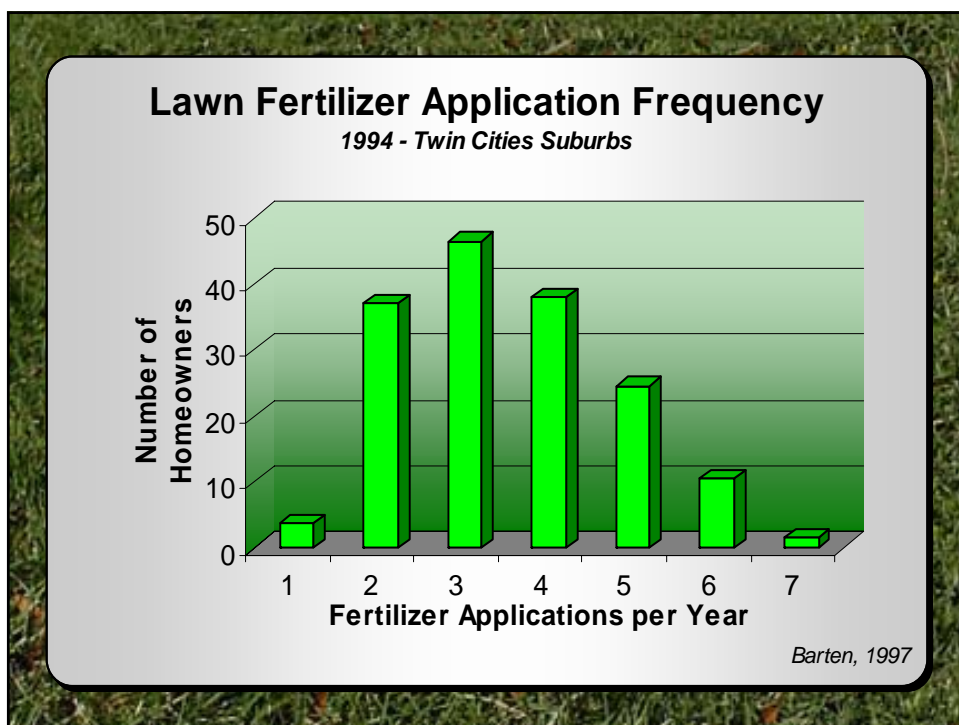
NITROGEN 1 LB/1000 SQ.FT. PHOSPHATE 0 LB/1000 SQ.FT. POTASH 1 LB/1000

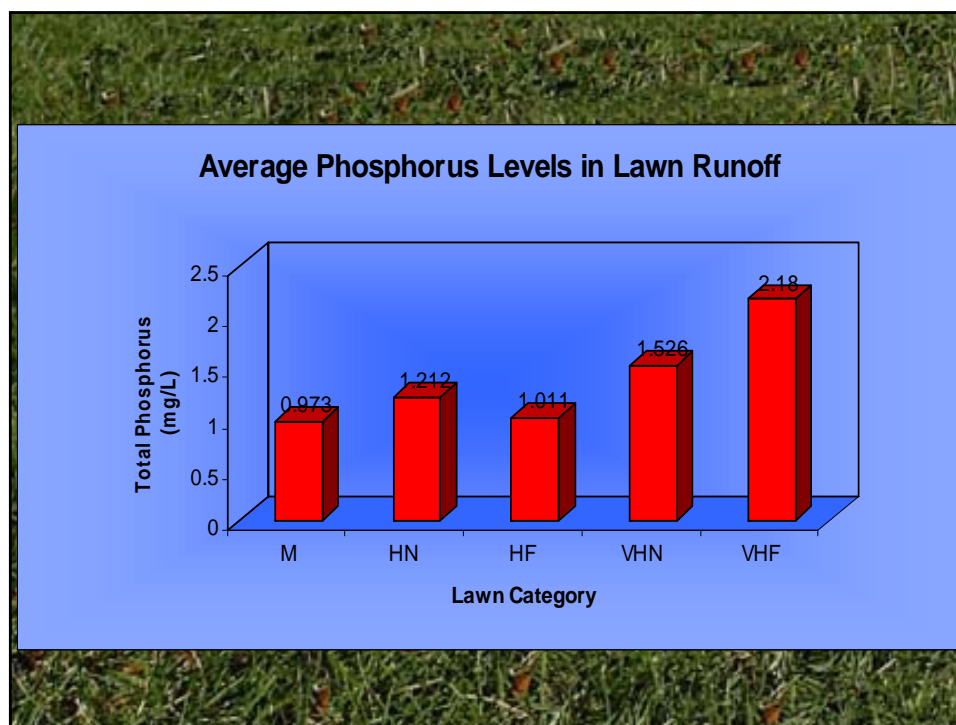
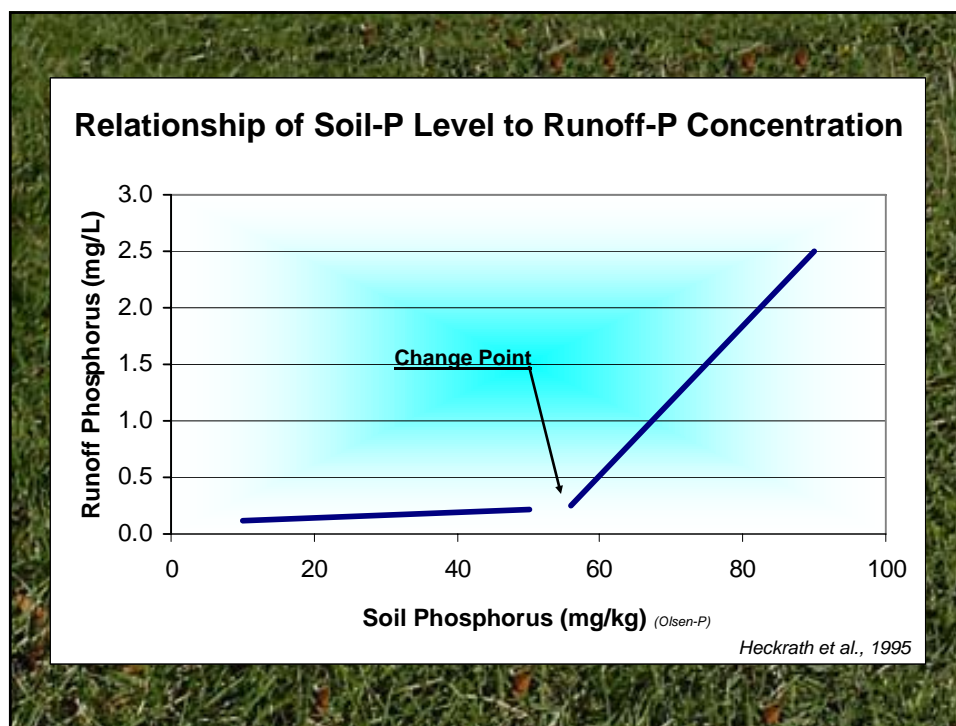
THE APPROXIMATE RATIO OR PROPORTION OF THESE NUTRIENTS IS: 5-0-5 OR 10-0-10

USE A FERTILIZER WITH THE PERCENTAGE OF NUTRIENTS CLOSEST TO THE ABOVE RATIO. APPLY ACCORDING TO THE INSTRUCTIONS ON THE FERTILIZER BAG OR CONTAINER, OR DETERMINE THE AMOUNT REQUIRED FROM THE INSTRUCTIONS GIVEN ON THE BACK SIDE OF THIS REPORT. SINCE MEETING THE AMOUNT REQUIRED FOR EACH NUTRIENT WILL NOT BE POSSIBLE IN MOST CASES, IT'S MORE IMPORTANT THE AMOUNT OF NITROGEN REQUIRED AND COMPROMISE SOME FOR PHOSPHATE AND POTASH.

APPLY TOTAL AMOUNT AT ONE TIME IN SEPTEMBER.

\* CAUTION DO NOT APPLY MORE THAN 1 LB NITROGEN PER 1000 SQ.FT. IN ONE APPLICATION TO A BURNING GRASS UNLESS A SLOW RELEASE FORM OR ORGANIC FERTILIZER IS USED. IT IS RECOMMENDED TO APPLY 50 PERCENT OF THE NITROGEN IN ONE APPLICATION AND 50 PERCENT IN A SECOND APPLICATION.





# Plymouth P-fertilizer Ordinance

- 1996: Commercial applicators restricted
  - Use only P-free fertilizer (some exceptions)
  - Require license to apply in Plymouth
  - Education of self-applicators
- 2000: Home-owner application restricted
  - Use only P-free fertilizer (some exceptions)
  - Additional rules prohibit application to impervious areas, waterways, and shorelines.
- \* 2002: Sales Restriction
  - Sell only P-free fertilizer unless soil test indicates a need for phosphorus





	Watershed Characteristics		
Site	Area (ha)	Impervious Area (%)	# Homes
MG1	5.5	43%	49
MG2	3.5	40.40%	36
MG3	16	35.20%	108
P1	5.1	44.60%	43
P2	6.8	43.50%	47
P3	5.6	28.40%	37

# Paired Watersheds

**Rainfall** - No Significant Difference

**Runoff** - Significantly Correlated

**Impervious Area** - MG 4-5% More

**Soil P** - Variable (majority H or VH)

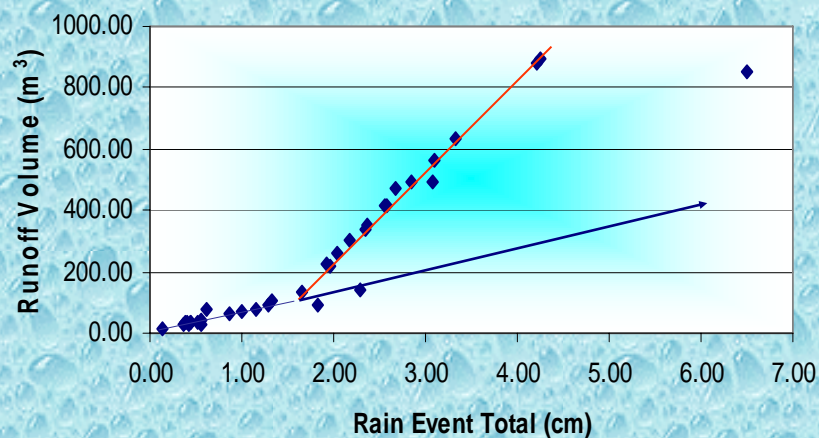
**Soil Compaction** - Little Difference

**Fertilizer Use** - Some Differences

**P-Application** - Large Differences

	New Developments		Middle-aged Developments		Older Developments	
	F1	MG1	F2	MG2	F3	MG3
<b>Rainfall (mm)</b>						
Mean	2.22	2.17	2.32	2.20	2.29	2.23
Median	1.33	1.30	1.21	1.18	1.14	1.35
Max	11.43	10.54	13.39	13.84	13.39	12.07
Min	0.04	0.03	0.04	0.05	0.03	0.10
N	64	64	64	62	63	63
<b>% Impervious Area</b>						
%	38.0%	42.5%	35.1%	39.4%	27.3%	34.2%
Hectares	1.92	2.35	2.39	1.39	1.54	5.42
<b>% Connected Impervious Area</b>						
%	23.9%	26.2%	22.9%	25.9%	17.8%	21.1%
Hectares	1.20	1.45	1.56	0.91	1.00	3.34
<b>Soil Compaction 0-10 cm (dBFa)</b>						
Mean	1.09	1.38	1.09	1.19	0.98	1.13
Median	1.10	1.33	1.06	1.15	1.02	1.12
Max	1.33	1.77	1.35	1.39	1.15	1.43
Min	0.86	1.09	0.76	1.06	0.75	0.89
N	6	10	7	4	6	13
<b>Zone of Maximum Compaction 0-10 cm (dBFa)</b>						
Mean Depth of Max (cm)	6.69	7.66	6.54	6.73	7.71	8.58
Mean Compaction at Max	1.61	2.06	1.39	1.74	1.30	1.70
SD of Max Compaction	0.137	0.149	0.141	0.189	0.104	0.124
Max Compaction Value	4.79	6.64	3.56	5.43	3.19	6.23
N	60	100	70	40	60	130
<b>Soil P Fertility 0-10cm (study watersheds only)</b>						
% Very High	36%	92%	90%	78%	89%	43%
% High	37%	8%	10%	22%	11%	26%
% Low-Medium	7%	0%	0%	0%	0%	30%
N	14	12	10	9	9	25
<b>Soil P Fertility 0-10cm (study watersheds and previous study data)</b>						
	Elmwood		Maple Grove			
% Very High	75.6%	75.5%	10%	22%	11%	26%
% High	22.2%	16.0%	0%	0%	0%	30%
% Low-Medium	2.2%	8.5%	0%	0%	0%	30%
N	90	94				
<b>% Homeowners that Fertilize Lawn</b>						
%	100%	100%	71.6%	88.9%	75.5%	91.7%
<b>% Homeowners that Applied Phosphorus</b>						
%	44.4%	63.6%	20.0%	83.3%	21.4%	73.7%
N	18	14	55	9	42	24

MG1 Runoff vs. Rainfall



## Reduction Potential

	TP		SRP	
	0-2cm	>2cm	0-2cm	>2cm
Mean Event Export (P-used) (g/ha/cm)	33.2 ± 15.9	23.1 ± 3.2	11.3 ± 7.4	15.2 ± 2.8
Mean Event Export (P-free) (g/ha/cm)	35.9 ± 7.9	18.7 ± 2.3	12.5 ± 3.8	7.9 ± 1.9
Mean Event Difference	0	5.2 ± 3.8	0	8.1 ± 3.5

% Annual Reduction	12 -16 %	24 – 34 %
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## Summary of Findings

- Runoff begins to occur from lawns in rain events > 2cm
- Watersheds with the fertilizer ordinance experienced:
  - Less P-fertilizer application (20% new / 50-60% older)
  - Fewer homes applying any fertilizer their lawns (15% less)
  - Significantly lower SRP loading (~30% less)
  - Significantly lower TP loading in all but newest watersheds (~16%)
- Higher TSS concentrations in Plymouth
  - may mask additional TP reduction attributable to the ordinance

## Conclusion:

Restricting use of P-fertilizer is an effective low cost BMP for reducing phosphorus in runoff from residential areas.

